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EVALUATION OF A PROTOTYPE MILITARY BACKPACK

by

B. Farnworth

NOVEMBER 1979
OTTAWA

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ABSTRACT

So // A prototype backpack under development by DCGEM has been tested by human subjects running an obstacle course. It was found to be more comfortable and marginally less of an encumbrance than the standard Canadian Forces rucksack.//

RÉSUMÉ

Un système de pertage à dos actuellement sous developpement par le DFGM a été mis a l'épreuve par des hommes en courant sur une piste d'obstacles. On a houvé que ce système est plus commode et un pur moins encombrant que le sac àdos des Forces canadiennes.

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INTRODUCTION

In May 1979 DCGEM asked for assistance from DREO in evaluating their current prototype Large Pack, a component of the Individual Load Carrying Equipment. Their need was for a short series of tests to be performed quickly and locally to isolate possible design or material defects before a more extensive user trial was to be undertaken by an infantry unit.

Accordingly a series of tests was scheduled for June 26, 27 and 28 to take place at the DREO Design and Wear Course (1). This course was built for the purpose of subjecting clothing to extreme abrasion and stretching and so is not entirely appropriate to the testing of backpacks. Nevertheless many of the obstacles did seem appropriate in that the passage of a soldier over these would be impeded by the carrying of a pack, especially a poorly designed one. Therefore, during the three-day trial, six military subjects seconded from 1RCR in London, Ontario were required to run, walk, crawl and climb around the course, carrying their packs over most of it but dragging them through some obstacles and throwing them over others.

The prototype Large Pack was compared to the standard CF rucksack subjectively by the opinions of observers and the test subjects themselves and, more objectively, by timing the test subjects through each circuit of the course. In addition the subjects were required to carry the Large Pack on an 8-km march and their comments were noted.

METHOD

Test Subjects

Personal data on the six military subjects are listed in Table I.

Table I

Physical Characteristics of the Test Subjects

Subject	Age (years)	Years of Service	Height (m)	Weight (kg)
1A	28	9	1.72	77
2A	19	1	1.72	61
3A	19	1	1.75	63
4A	19	1	1.80	77
5A	19	2.5	1.70	59
1B	19	2.5	1.85	77

Description of Packs

The standard CF rucksack and the prototype Large Pack are shown in Figure 1. The Large Pack differs from the CF rucksack in the following ways: in the construction of the frame, wire instead of tubing; in the location of the sleeping bag, below the pack rather than above; the number of compartments to the bag, two instead of one; and in the complexity of the carrying straps.

For this trial, the subjects packed the CF rucksack with their personal sleeping bag and clothing. The clothing was then repacked into the Large Packs along with complete sleeping bag assemblies supplied by DCGEM. Before each trial, the clothing was transferred to the pack to be tested in that particular run.

The loaded rucksacks weighed from 13.7 to 15.4 kg, the loaded Large Pack from 13.6 to 15.0 kg.

In order to check the Large Packs for any bending of the pack frames during the course of the trial the two diagonals and the maximum width of the frames were measured. They were measured again at the end of the 3 days. These data and the weights of the backpacks carried by each subject are listed in Table II.

Table II

Physical Measurements of the Packs

Subject	Rucksack Weight (kg ± 0.5)	Large Pack Weight (kg± 0.5)	Diagonal 1 (cm ±0.5)		Diagonal 2 (cm ±0.5)		Width (cm ±0.5)	
			before	after	before	after	before	after
1A	13.6	14.0	59.5	59	60	59	35.5	36
2A	15.4	15.0	59	60	59	59	35.5	36
3A	13.6	13.6	59	59.5	60	59	36	36
4A	12.7	13.6	59	59	59	59.5	36	36
5A	15.4	13.6	59.5	59	59.5	59.5	36	36.5
1B	13.6	15.0	59.5	59	59	58.5	35.5	36.5

Test Course

The DREO Design and Wear Course is described in detail in Reference 1. A plan of the course is reproduced in Figure 2. Not all the obstacles were included in this trial nor were those that were included necessarily used in the usual manner. The following is a list of departures from the description in Reference 1.

Obstacle	1	Crawl on hands and knees	14	run
	2	Crawl on hands and knees	15	run
	5	omit	17	run
	6	omit	18	run
	7	run	19	run
	8	jump	20	jump
	9	run	21	run
	10	run	22	jump
	11	jump	23	crawl, pushing pack
	13	run	24	run

Obstacle	25	omit (due to unsafe condition)
	26	run
	27	crawl, pulling pack
	28	throw pack down
	32	included initially then rejected during time trials due to slipperiness
	33	throw pack over
	34	omit
	36	climb up then down same side
	39	omit (due to unsafe condition)

The subjects had to remove their packs to negotiate obstacles 23, 27 and 33 and were also asked to drop then once more between obstacles 29 and 30.

The length of the course is approximately 600 m.

Procedure

Day 1

The test subjects were taken around the course and had the required method of negotiating each obstacle demonstrated to them. They then traversed the course carrying their own rucksack at a relaxed pace of 12-16 minutes.

The subjects then ran round the course three times with the Large Pack and then once more with the rucksack.

During this first day's trials the subjects proceded round the course in pairs, each pair accompanied by an observer. The observers noted any way in which either of the two types of pack seemed in interfer with movement over the obstacles. The test subjects were also asked for their opinions as to the relative merits of the two packs.

Day 2

Before the trials with packs, the subjects ran through the course without packs to warm up.

The subjects were then asked to traverse the course as quickly as possible, consistent with safety, and were individually timed. The six subjects were started at 2 minute intervals and ran the course 4 times with about 15 minute breaks between the 4 sets. The first time the Large Pack was carried; the next two, the rucksack; and finally, the Large Pack again. The weather was fine and dry except during the first timed trial, when it rained. The times for this trial were noticeably longer than for the other five, presumably because of the rain, so these data were ignored in the calculations of average times.

During the afternoon the six test subjects marched 8 km over a undulating gravel road. They carried the Large Packs and were asked for their comments. It was considered that they should be sufficiently familiar with the performance of their own rucksacks that a comparison could be made without a similar march with rucksacks.

Day 3

The subjects again ran through the course without packs to warm up. Two more timed trials, one with each pack, were conducted. Again the weather was fine and dry.

As a final attempt to inflict damage on the Large Pack, one was hauled by rope to the top of one of the obstacles and dropped, 10 times, to the sandy ground 8 m below.

The results of the timed trials are shown in Table III.

Table III

Times to Run the Course With Different Packs

Run	Pack	Day	Start Time	Time (min:sec ± 3 Sec) 1A	2A	3A	4A	5A	1B
1*	Lge pack	2	0855	10:20	8:50	9:20	8:45	10:35	8:10
2	Rucksack	2	0930	9:00	9:50	8:25	8:25	9:30	8:00
3	Rucksack	2	1000	8:55	9:10	8:25	8:15	9:00	7:40
4	Lge Pack	2	1030	8:55	8:40	8:40	8:00	9:00	7:55
5	none	3	0800	6:55	5:40	5:55	5:55	6:05	5:45
6	Lge pack	3	0830	9:05	9:15	8:15	9:05	9:00	7:55
7	Rucksack	3	0900	9:20	9:25	8:25	9:10	9:15	8:55
Average with Large Pack (4,6)				9:00	8:50	8:28	8:33	9:00	7:55
Average with Rucksack (2,3,7)				9:05	9:28	8:25	8:37	9:15	8:12
Difference: Large Pack-Rucksack				-:5	-:30	+:03	-:04	-:15	-:17

* Times not included in averages due to wet conditions during this run.

RESULTS AND DISCUSSION

Performance

Objective Appraisal

Consideration of the data in Table III shows that the Large Pack was marginally less of an encumberance over the obstacle course than the rucksack. All subjects traversed the course 2 to 3 minutes more slowly with either pack than with none. The difference between the two packs was that the times were an average of 11 sec faster with the Large Pack than the rucksack, the spread being from 30 sec faster to 3 sec slower. This difference would undoubtedly have been greater but for the fact that time was lost due to the slowness of removing the Large Pa.k without the use of the quick release.

Subjective Appraisal

It was noted by the observers and by the subjects themselves that the Large Pack fitted better than the rucksack in that the load was centred closer to the wearer's back and so did not have quite the same tendency to pull them backwards. This was especially noticeable on the climbing portions of the course. The improvement here seemed to be due to two design features. Firstly, the Large Pack was taller than the rucksack with a corresponding reduction in the fore-aft dimension and a forward shift in the centre of gravity of the load. Secondly, the design of the shoulder strap with attachments at two points at the top of the frame, instead of one on the rucksack, permitted the straps to be pulled tighter without discomfort so that the pack fitted closer to the body.

A second common observation was that the Large Pack was held more securely against the back and did not move around when the subject ran, crawled or climbed. This was in part due to the better fit, as noted above, but perhaps mainly due to the presence of a waist belt on the Large Pack and its absence from the rucksack. Although a waist belt is available for the rucksack, it is rarely used and often not even issued. This is because its use is awkard and uncomfortable. The waist belt on the Large Pack is, on the other hand, an integral part of the pack, easy to fasten and, with practice, easy to undo. As well as

helping secure the load to the body, it shifts some of the weight from the shoulders to the hips, significantly contributing to the comfort and stability of the wearer.

A critisism of both packs was that it was difficult to look up and forward while crawling, more so with the Large Pack than with the rucksack and especially when the top-most compartment of the Large Pack was full. If there is an operational requirement for a soldier to crawl or lie prone while wearing his pack, then the Large Pack must be considered slightly inferior to the rucksack in this regard.

Another major difference between the two packs was the ease with which they could be taken off, both with and without the use of quick release. These two cases should be considered separately.

During the timed trials, the test subjects were required to take off and put back on the pack several times without using the quick release. The Large Pack was found to be slower for two reasons. Firstly, the waist belt had to be undone and secondly, the tighter fit of the Large Pack made it more difficult to slip the arms out of the shoulder straps. In both these respects there is a trade-off between comfort and stability of the pack on one hand abd speed of release on the other. It does not seem likely that speed of release could be an over-riding consideration except in an emergency when, in any case, the quick release should be employed.

During the trials that were not timed the subjects were asked to drop the pack using the quick release. Here again the waist-band of the Large Pack was an encumberance but not a serious one as it can, with practice, be undone very quickly or, if the likelihood of an emergency is anticipated, it can be left undone. The Large Pack can be dropped very quickly indeed if both quick-release straps are pulled.

The unanimous opinion of the test subjects was that the Large Pack was superior in comfort and less of a hinderance over the obstacle course and on the 8 km march than was the rucksack. The only complaints were: the slowness of dropping the Large Pack, the design of the shoulder strap which on some subjects irritated the underarms, the closeness of fit which impeded ventilation and the dissipation of sweat from the back and the occasional riding up of the padded band at the bottom of the frame, exposing the buckle which then dug into the back.

To the observers it seemed that the Large Pack permitted greater stability and ease of motion than the rucksack.

Damage

The dimensions of the frame before and after the trial (see Table II) were the same within the accuracy of the measurement even for the pack (1B) which was repeatedly dropped from a height of 8 m. It is concluded that no significant bending of the frame took place.

No major damage was noted to the Large Pack although a few minor defects became apparent. Due to abrasion and strain the fabric, grommets and lacing on the Large Pack where it is joined to the top of the frame became worn indicating that this area "needs strengthening" Also one buckle, of the same type that is used on the rucksack, broke off the shoulder strap of one Large Pack. This type of buckle should probably be replaced.

CONCLUSIONS

Despite three days of rough handling, no major design or material defects in the prototype Large Pack became apparent though some minor modifications are indicated.

The Large Pack proved to be more comfortable and marginally less of an encumberance than the standard CF rucksack over a course involving walking, running, climbing and crawling. On an 8-km march the Large Pack was again judged more comfortable than the rucksack.

REFERENCE

1. R.W. Nolan and A. Dalpé, DREO Technical Note 77-18.

Figure 1. Prototype Large Pack on left and standard CF rucksack on right.

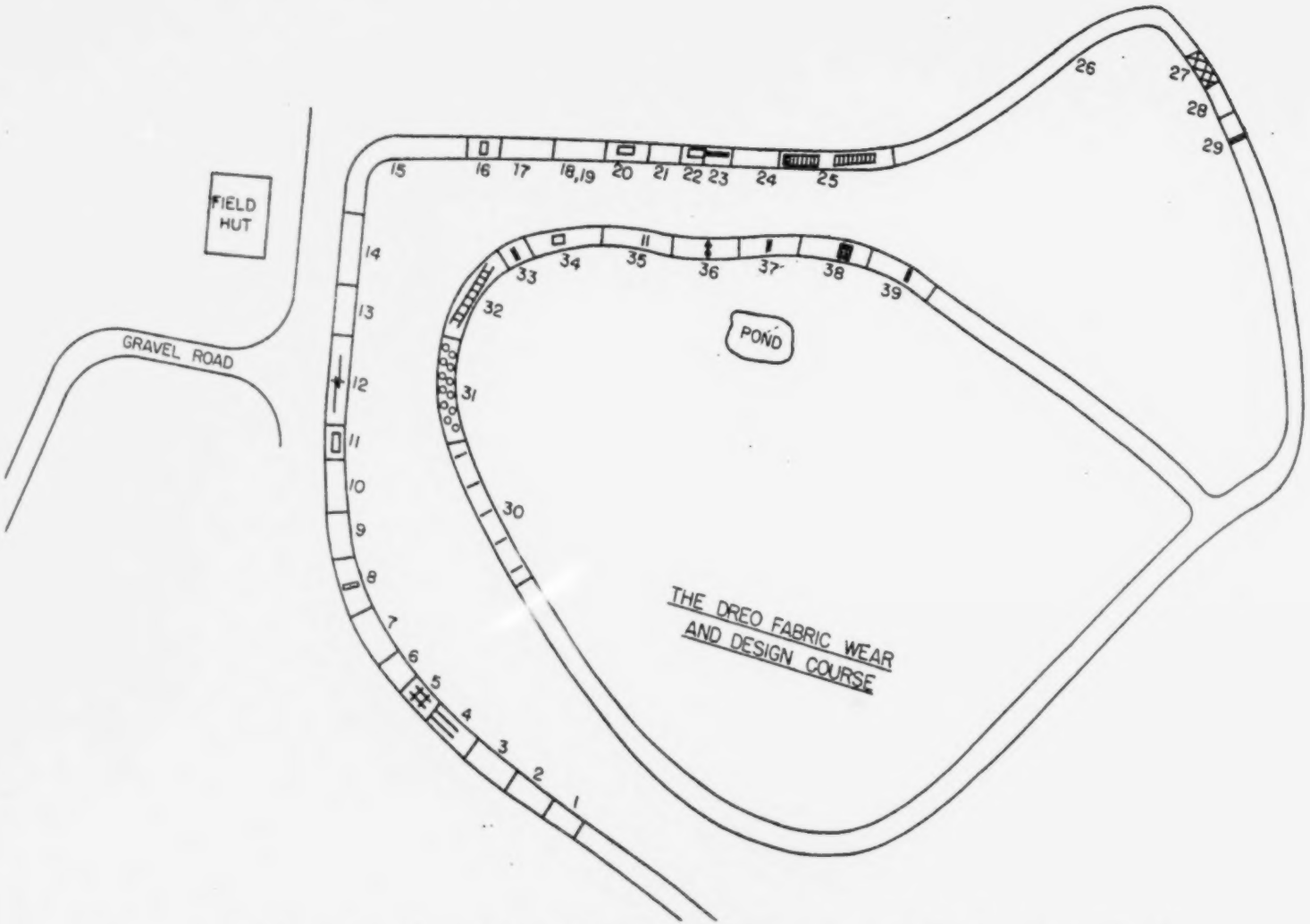

Figure 2. Plan of DREO Design and Wear Course. The subjects traversed the obstacles in numerical order but omitted some and crossed some in other than the usual manner.

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